The Ocean Observatories Initiative (OOI): Future of Time Series and Real-Time Monitoring

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OOI Program

The Ocean Observatories Initiative (OOI) is an NSF program funded to provide long-term (≥25 years) and synoptic measurements of physical, chemical, geological, and biological variables in the oceans and at the seafloor at key world sites (see Fig. 1). The networked infrastructure of science-based instrumented systems will address six major science themes:

- Ocean-Atmosphere Exchange
- Climate Variablility, Ocean Crculation, and Ecosystems
- Turbulent Mixing and Biophysical Interactions
- Coastal Ocean Dynamics and Ecosystems
- Fluid-Rock Interactions and Sub-Seafloor Biosphere
- Plate-Scale Geodynamics

The OOI marine infrastructure comprises three highly-instrumented observation systems functioning across multiple scales:

- **Global Scale Nodes** (GSN) at four high-latitude sites – Station Papa, Irminger Sea, Argentine Basin, and Southern Ocean;
- **Coastal Scale Nodes** (CSN) with arrays in the NE Pacific (Endurance Array) and mid-Atlantic (Pioneer Array);
- **Regional Scale Nodes** with a cabled high-power and high-bandwidth network spanning the Juan de Fuca Plate off the Oregon and Washington coast.

These marine components will be integrated into a single ocean observatory through a unique and overarching cyberinfrastructure, OOI Integrated Observatory Network (ION), providing full connectivity and control/coordination of the instrumentation as well as direct and free access (24/7) to the data for any user with internet connectivity.

With initial data streams envisioned for late summer 2013 (see OOI Timetable) and full system commissioning in 2015, the OOI will soon provide the ocean science community with continuous, high-quality, and easily accessible time-series data. Long-term and synoptic datasets with real-time monitoring and event response will allow scientists to conduct high-resolution and long-duration studies gaining transformational insight into ocean-atmosphere processes.

OOI Timetable – Marine Infrastructure Installation

2013	Summer:	Hydrate Ridge – Seafloor Instruments at Southern Hydrate Summit and Slope Base
		Axial Seamount – Seafloor Instruments at Summit of Axial Seamount
		Endurance Array (Oregon Line) – Benthic Experiment Packages (BEPs)
		Station Papa Array
	Fall:	Endurance Array (Oregon Line) – Profiler/Mooring Subset-1 and Gliders (6)
	Winter:	Pioneer Array – Profiler/Mooring Subset-1 and Gliders (6)
2014	Spring:	Endurance Array (Oregon Line) – Profiler/Mooring Subset-2
		Endurance Array (Washington Line) – Profiler/Mooring Subset-1
	Summer:	Irminger Sea Array
		Pioneer Array – Profiler/Mooring Subset-2 and AUV/Dock(1)
		Hydrate Ridge Region – Profiler/Mooring and Seafloor Instruments at Slope Base
		Axial Seamount – Profiler/Mooring and Seafloor Instruments at Base
	Fall:	Endurance Array (Oregon Line) – Profiler/Mooring Subset-3
		Endurance Array (Washington Line) – Profiler/Mooring Subset-2
		Pioneer Array – AUV(2) and Dock(1)
2015	Winter:	Argentine Basin Array
		Southern Ocean Array

Further details and up-to-date deployment and commissioning info are at www.oceanobservatories.org.

DISCLAIMER:

All data are subject to revision without notice; exact locations of mooring sites are not yet finalized; exact depths of instruments will be determined at the time of deployment.

Global Scale Nodes (GSN)

The GSN is the global component of OOI and its sites are situated in high-latitude areas (see Fig. 1): Irminger Sea (2800 m), Argentine Basin (5200 m), Southern Ocean (4800 m), and Station Papa (4250 m). Surface and flanking moorings with instruments at fixed depths, wire-following and surface-piercing profilers, and gliders will populate the sites with identical distributions at all sites other than Station Papa (see Fig. 1 and enlargements). The instruments on the various platforms are summarized in Table 1.

Table 1a Station Papa, Irminger Sea, Argentine Basin, Southern Ocean PROFILERS and GLIDERS

Instrument Type	Surface-Piercing Profiler (SPP)	Wire-Following Profiler (WFP)	Glider (GL)	Manufacturer/ Model
CTD	SS to 150	~240 to 2400 3900 (Pap) 4400 (Arg)	SS to 1000	GL: Sea-Bird GPCTD Others: tbd
Dissolved O_2 Stable Response	SS to 150	~240 to 2400 3900 (Pap) 4400 (Arg)	SS to 1000	GL: Aanderaa Optode 4831 Others: tbd
pCO_2 Water	SS to 150	–	–	tbd
Optical Nitrate	SS to 150	–	–	tbd
2-Wavelength Fluorometer	SS to 150	~240 to 2400 3900 (Pap) 4400 (Arg)	SS to 1000	GL: WET Labs ECO Triplet Others: tbd
Absorption Spectrophotometer	SS to 150	–	–	tbd
Spectral Irradiance	SS to 150	–	–	tbd
Velocity Meter (3D Single Point)	–	~240 to 2400 3900 (Pap) 4400 (Arg)	–	tbd
Bio-acoustic Sonar	150 Fixed (uplooking)	–	–	tbd

Arg = Argentine Basin; Pap = Station Papa. Depth range in meters below sea surface (SS). – = not present; tbd = to be determined

Coastal Scale Nodes (GSN)

The CSN component of OOI consists of the Endurance and Pioneer Arrays on the NE Pacific and mid-Atlantic coasts, respectively (see Fig. 1). These arrays are composed of site-specific combinations of EOM surface moorings, surface-piercing and wire-following profilers, gliders, and AUVs (see Figs. 3 and 4). Approximate water column depths are presented in Table 4, and instruments are summarized in Table 5.

Table 4 Pioneer and Endurance Array Moorings and Profiler WATER COLUMN DEPTHS (APPROXIMATE)

Mooring or Profiler Location	Endurance Array	Pioneer Array
Inshore Surface Mooring and Surface-Piercing Profiler	25 m	92 m
Central Inshore Profiler	–	125 m
Central Surface Mooring and Surface-Piercing Profiler	80 m (Shelf)	135 m
Central Offshore Profiler	–	150 m
Offshore Surface Mooring and Profiler	500 m (WA Line) 600 m (OR Line)	450 m

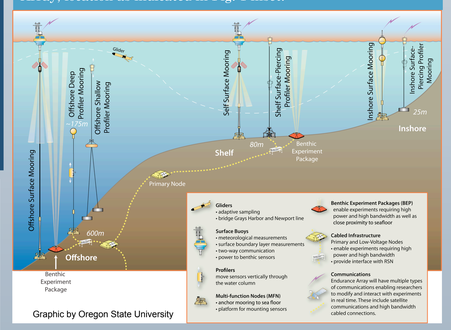
– = not present

Table 5a Pioneer and Endurance Array SURFACE MOORINGS and/or BENTHIC PACKAGES

Instrument Type	Surface Mooring Instrumented Depths	Manufacturer/Model tbd = to be determined
Bulk Meteorological Sensor Package	~3 m above SS	Star Engineering ASIMET
Direct Covariance Flux (High Power)	~3 m above SS	tbd
pCO_2 Air-Sea Interface	SS	Pro-Oceanus pCO2-pro
Surface Wave Spectra*	SS	Axys Technologies TRIAXYS
Pumped CTD	5; 2 m above bottom	Sea-Bird SBE 16plusV2
Dissolved O_2 Stable Response	5; 2 m above bottom	Aanderaa Optode 4831
pCO2 Water	2 m above bottom	SAMI-pCO2
Seawater pH	5; 2 m above bottom	Sunburst SAMI-pH
Optical Nitrate	5	Satlantic ISUS
3- Wavelength Fluorometer	5	WET Labs ECO Triplet-w
Absorption Spectrophotometer	5; 2 m above bottom	Wet Labs AC-S
Spectral Irradiance	5	Satlantic OCR507 ICSW
Velocity Meter (Single Point)	5; 2 m above bottom	Nortek Aquadopp 300 m
Velocity Profiler (short or long range)	bottom (uplooking)	Teledyne RDI Workhorse Monitor 150 kHz; LongRanger Sentinel 75 kHz (Offshore mooring)
Velocity Profiler† (short range)	5 m (down looking)	Teledyne RDI Workhorse Monitor 300 kHz
Seafloor Pressure	2 m above bottom	Sea-Bird SBE 26plus
Bio-acoustic Sonar	2 m above bottom	tbd
Broadband Hydrophone†	2 m above bottom	Ocean Sonics iCListen HF
Digital Still Camera w/ Strobe†	2 m above bottom	Kongsberg Model: tbd

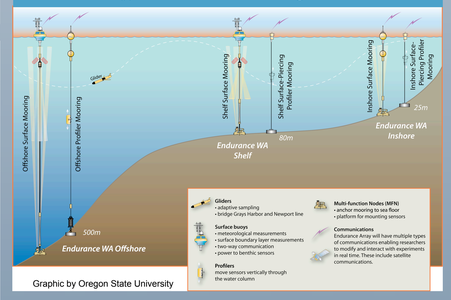
Depth range in meters below sea surface (SS) unless otherwise indicated
* Surface Wave Spectra Instrument only on Central Surface Mooring
† Endurance Array only

Figure 3a Schematic depicting Oregon Line of the Endurance Array, location as indicated in Fig. 1 inset.



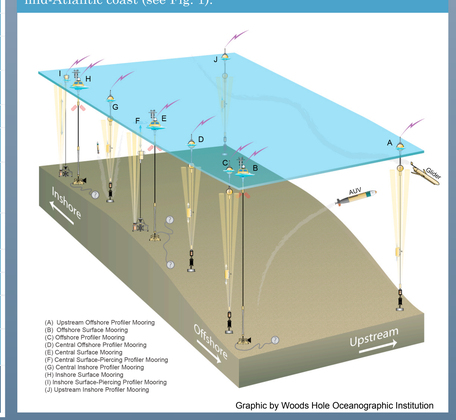
Graphic by Oregon State University

Figure 3b Schematic depicting Washington Line of the Endurance Array, location as indicated in Fig. 1 inset.



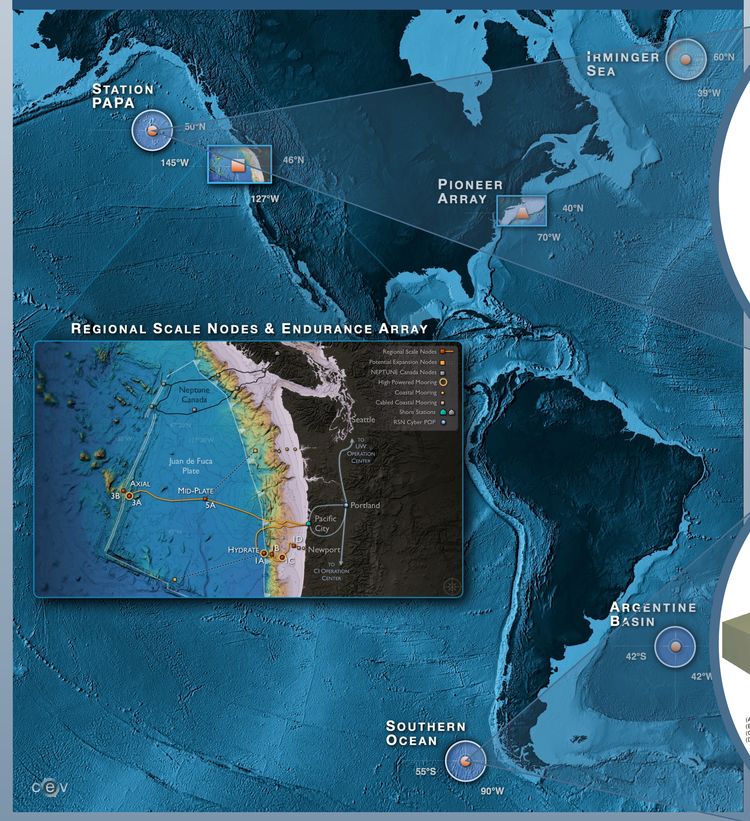
Graphic by Oregon State University

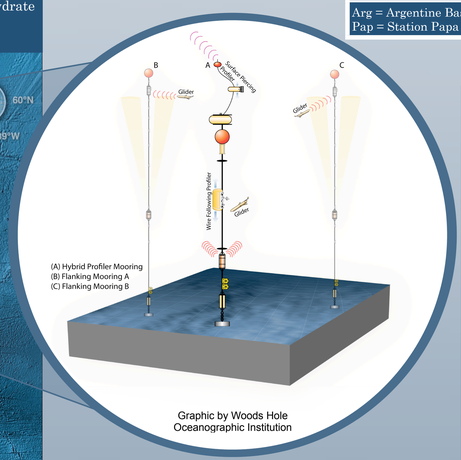
Figure 4 Schematic depicting the Pioneer Array situated on the mid-Atlantic coast (see Fig. 1).



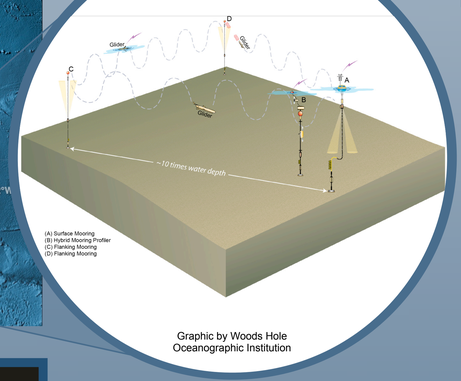
Graphic by Woods Hole Oceanographic Institution

Figure 1 The Ocean Observatories Initiative (OOI) infrastructure provides a network of scientific instrumentation at key sites. Inset details the cabled Regional Scale Nodes (RSN), with subsites at Axial Volcano and Hydrate Ridge, and Endurance Array off the Oregon and Washington Coast.





Graphic by Woods Hole Oceanographic Institution



Graphic by Woods Hole Oceanographic Institution

Table 1b Irminger Sea, Argentine Basin, Southern Ocean SURFACE MOORINGS

Instrument Type	Surface Mooring (SM)	Manufacturer/Model tbd = to be determined
Bulk Meteorological Sensor Package	~3 m above SS	Star Engineering ASIMET
Direct Covariance Flux (High Power)	~3 m above SS	tbd
pCO_2 Air-Sea Interface	SS	Pro-Oceanus pCO2-pro
Surface Wave Spectra	SS	Axys Technologies TRIAXYS
Pumped CTD	15	Sea-Bird SBE 16plusV2
Moored CTD (Inductive)	20;40,60;90;130 180;250;350;500 750;1000;1500	Sea-Bird SBE 37IM
Seawater pH	20;100	Sunburst SAMI-pH
3- Wavelength Fluorometer	15	WET Labs ECO Triplet-w
Velocity Meter (Single Point)	15	Nortek Aquadopp 300 m
Velocity Profiler	500 (uplooking)	Teledyne RDI Workhorse LongRanger Sentinel 75 kHz

Depth range in meters below sea surface (SS) unless otherwise indicated

Table 1c Station Papa, Irminger Sea, Argentine Basin, Southern Ocean FLANKING MOORINGS

Instrument Type	Flanking Mooring	Manufacturer/Model
Moored CTD (Inductive)	30;40;60;90;130 180;250;350;500 750;1000;1500	Sea-Bird SBE 37IM
Dissolved O_2 Stable Response	40	Aanderaa Optode 4831
Seawater pH	40	Sunburst SAMI-pH
3- Wavelength Fluorometer	40	WET Labs ECO Triplet-w
Velocity Profiler	500 (uplooking)	Teledyne RDI Workhorse LongRanger Sentinel 75 kHz

Depth range in meters below sea surface (SS) unless otherwise indicated

Table 5b Pioneer and Endurance Array PROFILERS, GLIDERS, and AUVs

Instrument Type	Surface-Piercing Profiler (SPP) SS to 2 m above bottom	Wire-Following Profiler (WFP) 15 m to near bottom	Glider (GL) SS to ≤1000	AUV (Pioneer only) SS to ≤600
CTD	tbd	tbd	Sea-Bird GPCTD	tbd
Dissolved O_2 Stable Response	tbd	tbd	Aanderaa Optode 4831	Aanderaa Optode 4330
pCO2 Water	tbd	–	–	–
Optical Nitrate	tbd	–	–	tbd
3-Wavelength Fluorometer	tbd	Wet Labs ECO Triplet	Wet Labs ECO Puck	tbd
PAR	tbd	tbd	Biospherical Instruments QSP-2155	Biospherical Instruments QSP-2155
Absorption Spectrophotometer	tbd	–	–	–
Spectral Irradiance	tbd	–	–	–
Velocity Meter (3D Single Point)	tbd	tbd	–	–
Velocity Profiler (short or long range)	–	*Teledyne RDI Monitor 150 kHz or LongRanger Sentinel 75 kHz (Offshore mooring)	Teledyne RDI EXplorer DVL 600 kHz	tbd (short range)

Depth range in meters below sea surface (SS) unless otherwise noted
* Fixed at bottom and uplooking
† = no Velocity Profiler at offshore profiler mooring
– = not present; tbd = to be determined

Regional Scale Nodes (RSN)

The RSN is the cabled component of the OOI and is the first U.S. Ocean Observatory to fully span a tectonic plate. Through the use of high-power (10 kV DC, 8 kW) and high-bandwidth (10 GbE) backbone cables, the RSN will provide unprecedented power, communication, and expandability to the OOI. Figure 2 depicts the RSN-cabled water column moorings and profilers to be deployed on the Juan de Fuca Plate. Instruments are summarized in Table 3. (NOTE: Not included in this poster are additional suites of seafloor instruments located at Hydrate Summit and Axial Volcano Caldera for studies of geodynamics and physical/chemical/biological processes associated with plate tectonics.

Figure 2 The RSN hosted high-power (3 kW) and bandwidth (1 GbE) water column moorings with shallow and deep profilers and a fixed 200 m platform at Sites 1A, 1C, and 3A (see Fig 1). The onboard instruments are summarized in Table 3.

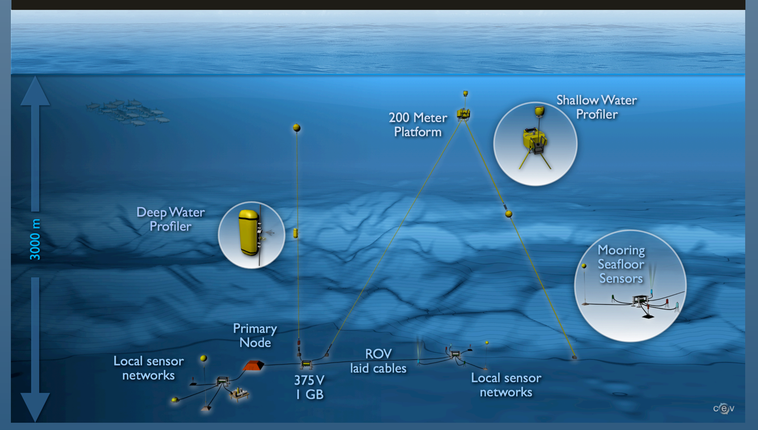


Table 3 Axial Base 3A (~2610 m), Hydrate Slope Base 1A (~2930 m), Endurance Array Offshore (600 m) SHALLOW AND DEEP PROFILERS , and 200 M MOORING PLATFORM

Instrument Type	Shallow Profiler (NSS to 200 m)	Deep Profiler (200 m to NSF)	200 m Platform	Mooring Seafloor
CTD	Sea-Bird SBE 16plusV2	Seabird SBE 52MP	Sea-Bird SBE 16plusV2	Sea-Bird SBE 16plusV2
Dissolved O2 Fast Response	Sea-Bird SBE 43	–	–	
Dissolved O_2 Stable Response	–	Aanderaa Optode 4831	Aanderaa Optode 4831	Aanderaa Optode 4831
pCO_2 Water	SAMI-pCO_2	–	–	–
Seawater pH	Sunburst SAMI-pH	–	Sunburst SAMI-pH	–
Optical Nitrate	Satlantic Deep SUNA	–	–	–
2-Wavelength Fluorometer	–	–	Wet Labs ECO Triplet-w	–
3-Wavelength Fluorometer	Wet Labs FLNTURTD + FLCDRTD	Wet Labs FLNTURTD+ FLCDRTD	–	–
PAR	Satlantic Digital PAR	–	–	–
Absorption Spectrophotometer	Wet Labs AC-S Deep	Wet Labs AC-S Deep	–	Wet Labs AC-S Deep
Spectral Irradiance	Satlantic OCR507 ICSW	–	–	–
Velocity Meter (3D Single Point)	tbd	tbd	–	–
Velocity Profiler (~300 m range)	–	–	Teledyne RDI Workhorse Monitor 150 kHz (uplooking)	Teledyne RDI Workhorse Monitor 150 kHz (uplooking)
Velocity Profiler 5-Beam (50 m range)	–	–	Teledyne RDI Workhorse Custom 600 kHz (uplooking)	–
HPIES	–	–	–	Non-commercial
Broadband Hydrophone	–	–	Ocean Sonics iCListen HF	Ocean Sonics iCListen HF
Digital Still Camera w/ Strobe	–	–	Kongsberg Model: tbd	–

– = not present; tbd = to be determined
Depth in meters below sea surface; NSS = near sea surface; NSF = near seafloor

For more information on: OOI see www.oceanobservatories.org
RSN see www.interactiveoceans.washington.edu